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Science | Sciences
Quebec Region
Canadian Science Advisory Secretariat
Science Advisory Report 2013/036

ASSESSMENT OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13 TO 17, 12A, 12B, 12C AND 16A) SNOW CRAB STOCKS IN 2012

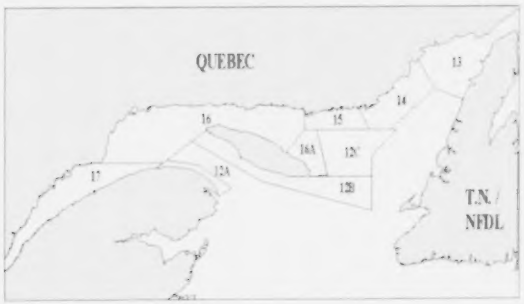


Figure 1. Snow crab management areas in the Estuary and the northern Gulf of St. Lawrence.

Context

The snow crab fishery in the Estuary and the northern Gulf of St. Lawrence began in the late 1960s. The fishery experienced a boom from 1979 to 1985 and a management approach based on the TAC (total allowable catch) was gradually introduced between 1985 and 1995. There are nine management areas (13 to 17, 16A, 12A, 12B and 12C) (Figure 1).

Landings have varied depending on the adjusted TACs based on the recruitment waves and troughs that have affected the fishery (Figure 2), with maximum levels recorded in 1995 (7 879 t) and 2002 (10 372 t). Landings dropped considerably in 2003 owing to the lower TACs established in response to signs of overfishing, mainly in Area 16. Landings totalled 7 866 t in 2012.

The fishery targets only males with a carapace width ≥ 95 mm. White crab (crab that has recently moulted) and adolescent males may be returned to the water during the fishing season to enhance their meat yield and give them a chance to reproduce. Furthermore, since 1985, when the proportion of white crab in catches at sea exceeds 20%, the fishery in the area concerned is automatically closed to minimize the mortality of these very fragile crabs that will be available to the fishery the following year.

The DFO Fisheries and Aquaculture Management Branch, Quebec Region, requested a resource status assessment as well as scientific advice in order to set the 2013 quotas. A scientific peer review was conducted on February 19 and 20, 2013. Participants included representatives from DFO Science and Fisheries and Aquaculture Management, the fishing industry, provincial governments, and First Nations.

July 2013

Canada

SUMMARY

- In 2012, stocks in the Middle and Lower North Shore of the Gulf of St. Lawrence (areas 13, 14, 15, 16, 16A and 12C) and south of Anticosti Island (Area 12B) had stable or increasing residual biomass and high recruitment to the fishery. This abundance of recruits is explained by a recruitment wave in this part of the Gulf of St. Lawrence. Conversely, stocks further south (areas 12A and 17) are characterized by low recruitment and a moderate to high, but declining, residual biomass.
- The purpose of conservation is to maintain an adequate male reproductive biomass in order not to adversely affect the recovery or maintenance of the population in a given area. Recommendations assume that the natural mortality rate will be the same in 2012 as in previous years.

Recommendations

- **In areas 17 and 12A**, maintaining the 2012 TAC at 1 809 t and 162 t, respectively, for 2013 is recommended to avoid creating an excessively high harvesting intensity and to protect against possible white crab issues.
- **In Area 16**, for 2013, a maximum 25% increase in catches (4 608 t) over the 2012 TAC would not result in an excessively high harvesting intensity.
- **In Area 12B**, a 15 to 20% increase of the 2012 TAC in 2013 (from 374 to 390 t) would not result in an excessively high harvesting intensity.
- **In Area 15**, for 2013, a maximum 10% increase in catches (653 t) over the 2012 TAC would not result in an excessively high harvesting intensity.
- **In Area 14**, for 2013, a maximum 10% increase in catches (448 t) over the 2012 TAC would not result in an excessively high harvesting intensity.
- **In Area 12C**, for 2013, a maximum 10% increase in catches (352 t) over the 2012 TAC would not result in an excessively high harvesting intensity.
- **In Area 16A**, for 2013, a maximum 10% increase in catches (469 t) over the 2012 TAC would not result in an excessively high harvesting intensity.
- **In Area 13**, an increase in 2013 catches to a value not exceeding 188 t would not result in an excessively high harvesting intensity.

INTRODUCTION

Species biology

In Canada, Snow Crab can be found from the southern tip of Nova Scotia to halfway up the Labrador coast, as well as in the Estuary and Gulf of St. Lawrence. In the Gulf of St. Lawrence, commercial-size males live at depths ranging from 60 to 220 m, except during their moulting and reproductive periods, during which they migrate to shallower waters. Snow Crab stop growing after their terminal moult. Males are considered adolescents (small claws) prior to the terminal moult and adults (large claws) afterward. Male carapace width (CW) ranges from 40 to 165 mm after the terminal moult. If they do not undergo their terminal moult earlier, males reach legal size (95 mm CW) at about nine years of age. Snow Crab recruitment is periodic or

episodic and varies considerably over an 8- to 12-year cycle. The entry of recruits into the fishery can be determined by regular monitoring of landings (carapace size and condition) and the catch rate (catch per unit effort, CPUE), and is confirmed by scientific trap and trawl surveys.

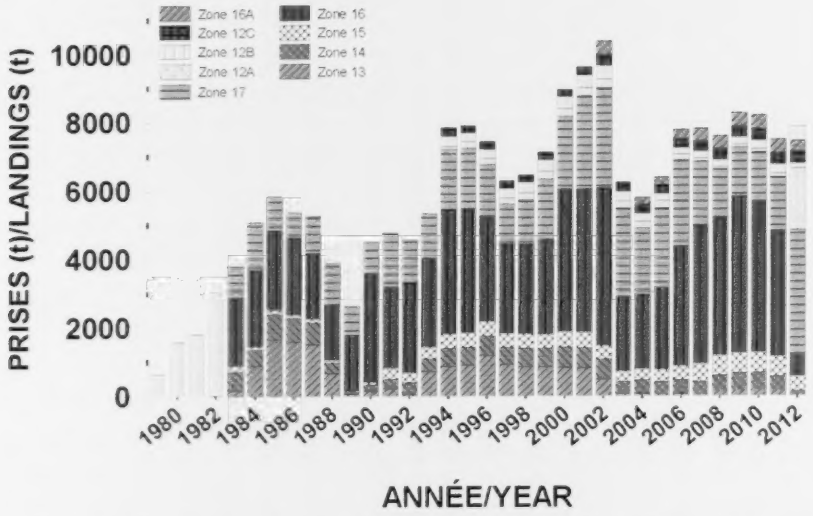


Figure 2. Snow Crab landings in the Estuary and northern Gulf of St. Lawrence. From 1979 to 1982, landings were not differentiated by area.

ASSESSMENT OF THE RESOURCE

Analyses of all areas are based on fishing data from logbooks, processing plant purchase slips and dockside weighing summaries, along with catch sampling data obtained from the Observers Program and DFO samplers. In 2012, the industry conducted a trap-based research survey in all fishing areas and the findings were incorporated into the stock status analyses. These surveys help determine the average NUE (numbers per unit effort) of legal-size crabs by area and the NUE of adolescent crabs with carapaces over 78 mm wide that will reach or exceed legal size during the next moult. The results of the trawl research surveys conducted in 2011 and 2012 in areas 17 and 13 were used to calculate a juvenile or adult crab abundance index.

The fishery's raw catches per unit effort (CPUE) were standardized using an additive model to account for seasonal changes, gear type, soak time and fishing site. The proportion of recruits (or new crabs), which can be identified by their new carapace (carapace conditions 1 and 2), was determined by dockside samplers.

A combined index equivalent to the post-season NUE and commercial CPUE averages was developed to determine the short-term biomass trend.

Data on the size structure of crabs sampled at sea, dockside and during trap surveys were also used.

To date, data on female insemination levels have been collected sporadically in certain areas. Annual systematic sampling of each area is recommended so this parameter can be used for

stock status assessments because it is a measure of primiparous female mating success and the relative abundance of large adult males (Sainte-Marie et al. 2002, 2008).

Area 17

Description of the fishery

In Area 17, there are 22 fishers who hold regular licences in group A (88% of the TAC) and some beneficiaries of temporary allocations in group B (12% of the TAC). The TAC decreased by 44% between 2006 and 2008, remained unchanged in 2009 and 2010, and increased by 10% in 2011 and by 15% in 2012 to 1809 t (Figure 3). The fishing season opened on March 29, closed on June 20 and the TAC was met.

Resource status in 2012

In the commercial fishery, the standardized CPUE remained high from 2000 to 2004 then decreased by nearly 50% between 2004 and 2008 (Figure 4). It trended upward from 2009 to 2011 then decreased to near average in 2012. Landings were dominated by recruits (new crabs, carapace conditions 1 and 2) from 2007 to 2009 and have been dominated by intermediate-shell crabs (condition 3) since 2010 (Figure 5). The average size of legal-size crabs caught at sea was slightly above average from 2007 to 2010 and well above average at 113 mm in 2011 and 2012 (Figure 6).

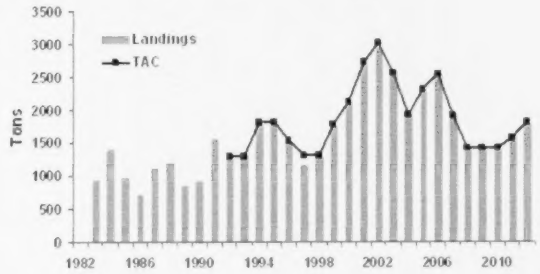


Figure 3. Landings and TAC in Area 17 from 1983 to 2012.

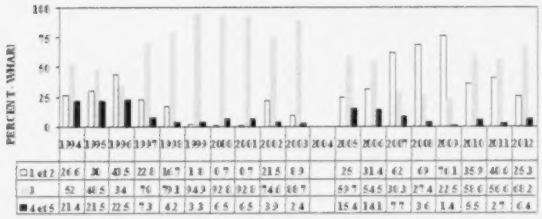


Figure 5. Carapace conditions for commercial crabs landed in Area 17 from 1994 to 2012.

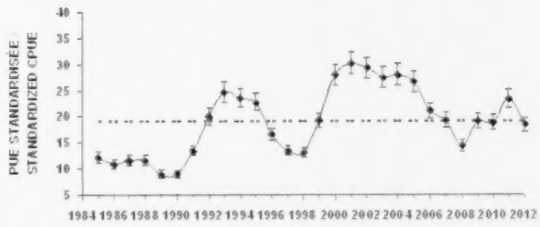


Figure 4. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2012 in Area 17. The dotted line shows the data series average.

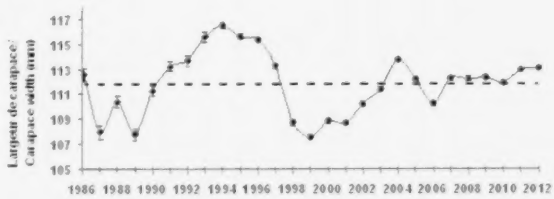


Figure 6. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1986 to 2012 in Area 17. The dotted line shows the data series average.

Results of the trap-based research survey, a data series that began in 1996 on the north shore and in 1999 on the south shore, indicate that the NUE of adults ≥ 95 mm decreased by

more than 50% from 2005 to 2007 and remained below average from 2007 to 2012 (Figure 7). The number of crabs left by the fishery (i.e. intermediate-shell or old crabs, conditions 3 to 5) followed the same trend from 2007 to 2011 then slightly increased to average in 2012. The number of recruits (conditions 1 and 2) remained near average from 2005 to 2008, then reached very high levels in 2009 and 2010 (Figure 8) before decreasing sharply for two consecutive years to well below average in 2012. After reaching the highest value in the series in 2009, the number of adolescents ≥ 78 mm caught in traps decreased significantly until 2012 to well below average (Figure 8). The average size of legal-size adult crabs decreased during the 2012 post-season survey, suggesting that it will do likewise during the 2013 commercial catch.

The combined index of commercial CPUE and of NUE in the post-season survey decreased in 2012 and is near the values observed in 2009 and 2010. This index suggests that the biomass available to the fishery in 2013 will be lower than there was in 2012.

Results from the trawl survey conducted on the north shore of the Estuary in 2011 showed that the abundance of adolescents between 78 and 95 mm decreased slightly from 2009 (13.9 crabs/10 000 m2) to 2011 (8.6 crabs/10 000 m2) and was low, whereas the abundance of adolescents between 40 and 78 mm, which was low, increased from 20.5 crabs/10 000 m2 to 192.6 crabs/10 000 m2 during this period. The abundance of males ≤ 40 mm, which was very high in 2009, decreased but remained high in 2011 at 350.4 crabs/10 000 m2. Consequently, there will be no significant recruitment to the fishery in the short term, but this recruitment is expected to be high as of 2015. A review of size frequencies shows a high density of immature females between 20 and 55 mm in 2011, indicating that primiparous females will be abundant in the short and medium term.

In 2012, the average amount of sperm stored in the females' spermathecae was low, indicating a sex ratio imbalance favouring females.

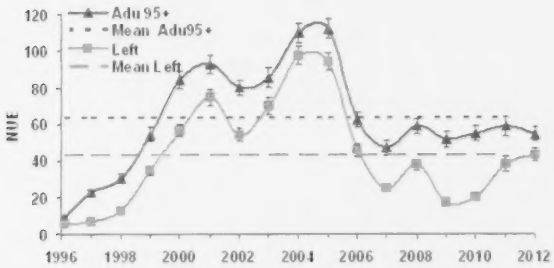


Figure 7. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 17 from 1996 to 2012.

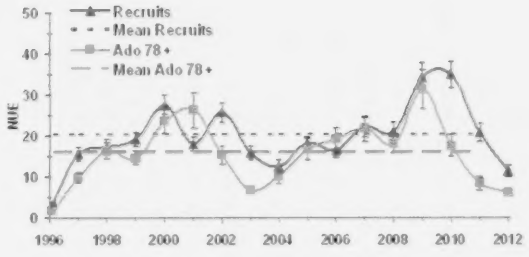


Figure 8. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 17 from 1996 to 2012.

Conclusion and advice

The TAC increased by 15% between 2011 and 2012 to 1 809 t and was met.

The catch rate during the 2012 commercial fishery decreased and was near average. Landings consisted primarily of intermediate-shell crabs.

The catch rate in the post-season survey decreased slightly in 2012 and has remained below average since 2007. This survey suggests that 2013 fishing yields could decrease slightly compared to those of 2012 and that mainly, intermediate-shell or old crab will be available.

The combined commercial CPUE and post-season NUE index suggests that there will be less biomass available to the fishery in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery remained stable in 2012 and was high, but it should decrease in 2013 according to the post-season survey.

The post-season survey suggests that there will be little recruitment to the fishery in 2013. This is consistent with the results of the 2011 trawl survey, which indicates that the stock is currently in a recruitment trough.

Maintaining of increasing 2012 catches in 2013 would result in a harvesting intensity greater than that in 2012. An increase in catches may result in a greater reduction of the legal-size adult male biomass because of low recruitment; this would make the fishery more vulnerable to the presence of white crab in catches when recruitment resumes in 2014. Moreover, a significant decrease in large adult males could result in a decline in reproductive success because, according to the trawl survey, primiparous females will remain abundant in 2013 and 2014.

Recommendation

Maintaining the 2012 TAC (1 809 t) in 2013 to avoid creating an excessively high harvesting intensity and to protect against possible White Crab issues.

Area 16

Description of the fishery

In Area 16, there are 39 fishers who hold regular Snow Crab licences in group A (92.7% of the TAC) and 20 who hold special Snow Crab licences in group B (7.3% of the TAC). After having peaked at 4 606 t in 2009 and 2010, the TAC decreased by 20% in 2011 to 3 686 t and remained unchanged in 2012 (Figure 9). The fishing season opened on April 1, closed on July 7 and the TAC was met.

Resource status in 2012

In the fishery, the standardized CPUE, which remained slightly above average in 2008 and 2009, decreased significantly in 2010 before increasing in two consecutive years to well above average in 2012 (Figure 10). Landings since 2006 (Figure 11) consisted primarily of recruits (carapace conditions 1 and 2) and very few old crabs (conditions 4 and 5), which, at the outset, could have been caused by high fishing pressure that was recently followed by high recruitment to the fishery. The average size of legal-size crabs caught at sea has increased since the historic trough of 2002 and been at or above average since 2006. In 2012, it was 111.1 mm (Figure 12).

The trap-based research survey conducted every fall since 1994 shows that the NUE of adults ≥ 95 mm increased in 2011 and 2012 after having trended downward from 2007 to 2010 and reached the highest value in the historical series (Figure 13). The number of intermediate-shell or old crabs (conditions 3, 4 and 5) left by the fishery also decreased from 2007 to 2010 and increased slightly in 2011 to a value that remained unchanged in 2012 (Figure 13). The number of recruits (conditions 1 or 2) had been above average since 2007, reaching the highest value in the series in 2012 (Figure 14). More biomass should therefore be available at the beginning of the 2013 season than in 2012. During the survey, the average size of adult crabs ≥ 95 mm increased very slightly between 2011 and 2012, suggesting that there will be no change in commercial catches in 2013 compared to 2012.

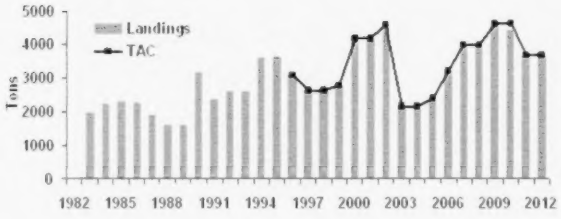


Figure 9. Landings and TAC in Area 16 from 1983 to 2012.

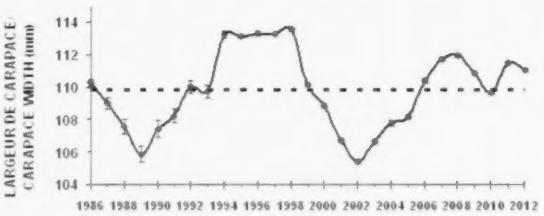


Figure 12. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1986 to 2012 in Area 16. The dotted line shows the data series average.

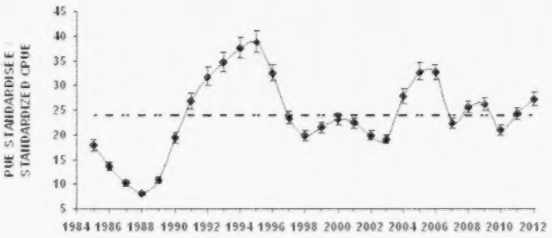


Figure 10. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2012 in Area 16. The dotted line shows the data series average.

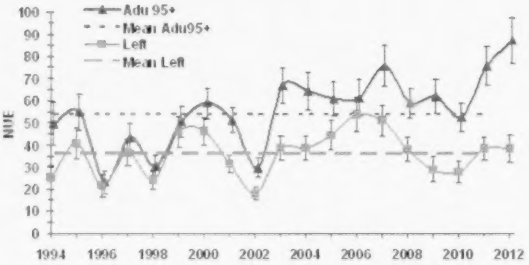


Figure 13. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 16 from 1994 to 2012.

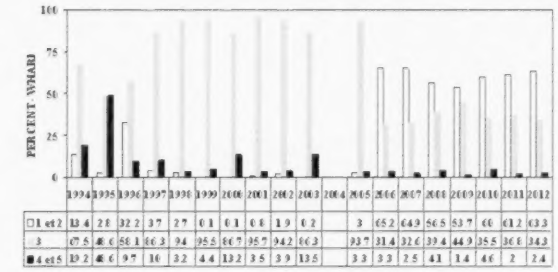


Figure 11. Carapace conditions for commercial crabs landed in Area 16 from 1994 to 2012.

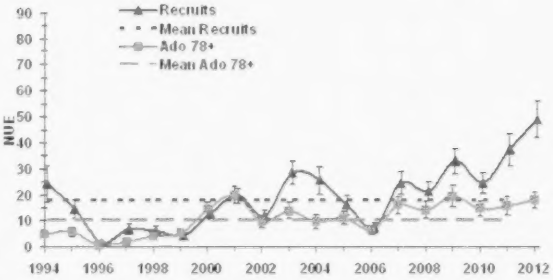


Figure 14. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 16 from 1994 to 2012.

The average NUE of adolescents ≥ 78 mm has been well above average since 2007 (Figure 14), which suggests that good short-term recruitment has been maintained.

The combined index of commercial CPUE and of NUE in the post-season survey increased to its historic high in 2012. This index suggests that there will be more biomass available to the fishery in 2013 than there was in 2012.

Results from the trawl survey conducted in Sainte-Marguerite Bay near Sept-Îles indicate a recruitment wave consistent with post-season survey observations. This recruitment wave should help maintain a large commercial biomass.

The spermathecae of primiparous females from Sainte-Marguerite Bay contained more sperm in 2012 than in 2011, indicating a greater relative availability of large males.

Conclusion and advice

The TAC decreased by 20% in 2011 and remained stable at 3 686 t in 2011 and in 2012, when it was met.

The catch rate increased to above average during the 2012 commercial fishery. Landings have consisted primarily of recruits since 2006.

The post-season survey suggests that there will be more biomass available to the fishery in 2013 than there was in 2012 and that landings will still consist primarily of recruits.

The combined commercial CPUE and post-season NUE index is very high and suggests that there will be more biomass available in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery decreased slightly in 2012 but remains well above average. It should remain stable in 2013 according to the post-season survey.

The post-season survey indicates high recruitment in 2012. This is consistent with the trawl survey conducted in the western part of the area. Therefore, the fishery should be driven by a recruitment wave that should continue until 2015.

The increase in the combined biomass index and the maintenance of high recruitment of legal-size crabs indicate that catches can be increased in 2013 without creating an excessively high harvesting intensity.

Recommendation

For 2013, increasing catches to a maximum of 25% (4 607.5 t) of the 2012 TAC would not result in an excessively high harvesting intensity.

Area 15

Description of the fishery

Area 15 has eight regular fishers. Since 2008, the TAC has peaked at 593 t (Figure 15), including 55 t in temporary allocations. In 2012, the fishery opened on April 9 and closed on July 15. The TAC has always been met.

Resource status in 2012

The standardized CPUE from the commercial fishery has increased since 2003 and was well above average from 2006 to 2010. It then decreased to average in 2011 before increasing significantly in 2012 (Figure 16). Although landings have consisted primarily of intermediate-shell crabs (condition 3) since 2008, the proportion of recruits (conditions 1 and 2) was higher in 2012 whereas the proportion of old crabs (conditions 4 and 5) remained stable (Figure 17). The average size of legal-size crabs caught at sea decreased in 2010 and 2011 then increased sharply in 2012 to 112.4 mm (Figure 18).

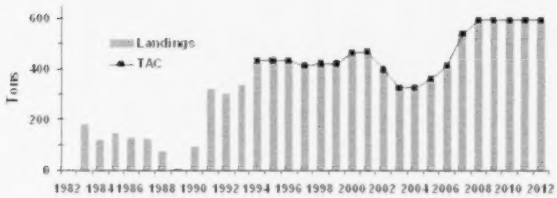


Figure 15. Landings and TAC in Area 15 from 1983 to 2012.

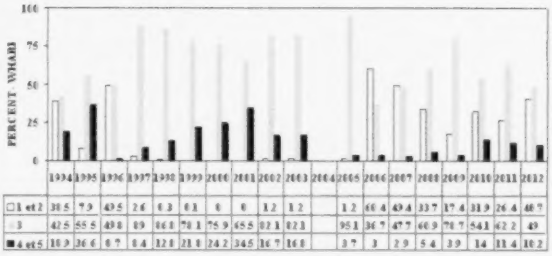


Figure 17. Carapace conditions for commercial crabs landed in Area 15 from 1994 to 2012.

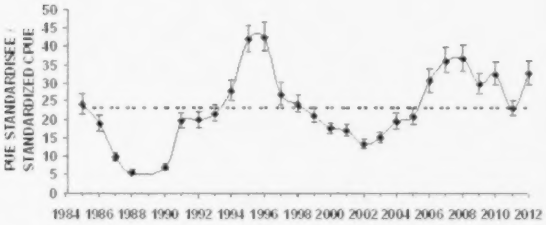


Figure 16. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2012 in Area 15. The dotted line shows the data series average.

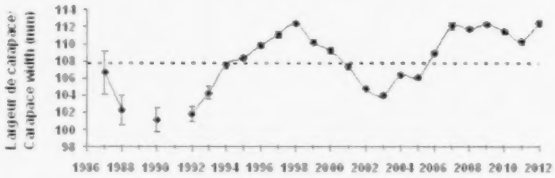


Figure 18. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1987 to 2012 in Area 15. The dotted line shows the data series average.

The **trap-based research survey**, which has been conducted since 1998, shows that the NUE of adults ≥ 95 mm was high from 2005 to 2009, then dropped to below average in 2010 before rebounding in 2011 to above average values that remained stable in 2012 (Figure 19). The abundance of intermediate-shell or old crabs (conditions 3, 4 and 5) has been below average since 2010 (Figure 19). The high NUE values for legal-size crabs in 2011 and 2012 are related to a high abundance of recruits (conditions 1 and 2) for those two years (Figure 20). Thus, the post-season survey results suggest that the biomass available at the beginning of the 2013 season will remain high. The average size of adult crabs ≥ 95 mm remained stable from 2011 to 2012, suggesting that this size will vary little in commercial catches in 2013. Since it significantly increased in 2011, the NUE of adolescents ≥ 78 mm has been at a historic high, suggesting that recruitment to the fishery will still be high (Figure 20).

The combined index of commercial CPUE and of NUE from the post-season survey increased to a relatively high value. This index suggests that there will be more biomass available to the fishery in 2013 than there was in 2012.

Conclusion and advice

The TAC and landings have peaked at 593 t since 2008.

The commercial fishery catch rate increased to above average in 2012. Landings consisted of a slight majority of intermediate-shell crabs although there was a significant proportion of recruits.

The post-season survey suggests that fishing yields will remain high in 2013 and include mostly intermediate-shell crabs and a relatively high proportion of recruits.

The combined commercial CPUE and post-season NUE index is relatively high and suggests that there will be more biomass available in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery increased and remains well above average. It should remain high in 2013 according to the post-season survey.

The abundance index of recruits and of adolescents ≥ 78 mm in the post-season survey remained high in 2012, foreshadowing the maintenance of high recruitment in the short term.

The increase in the combined biomass index and the maintenance of high recruitment of legal-size crabs indicate that catches could be slightly increased without creating an excessively high harvesting intensity.

Recommendation

For 2013, increasing catches to a maximum of 10% of the 2012 TAC (652.3 t) would not result in an excessively high harvesting intensity.

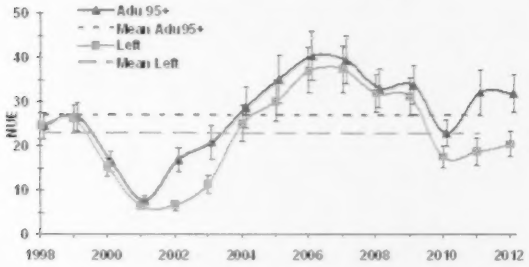


Figure 19. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 15 from 1998 to 2012.

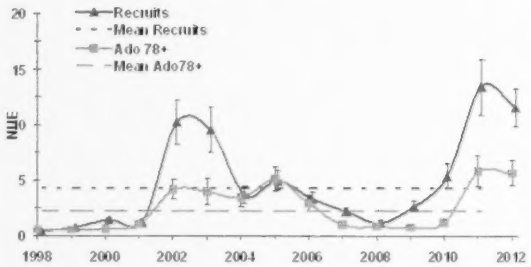


Figure 20. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 15 from 1998 to 2012.

Area 14

Description of the fishery

Area 14 has 21 regular fishers. The TAC decreased by 20% to 407 t between 2010 and 2011 and remained unchanged in 2012 (Figure 21). In 2012, the fishing season opened on May 16 and closed on August 18. The TAC was met.

Resource status in 2012

The standardized CPUE from the commercial fishery surged to a high value from 2007 to 2009, then decreased sharply to a well below average value in 2010. The value remained stable in 2011 following a decrease in the TAC and there has been no change since (Figure 22). Intermediate-shell crabs (condition 3) have clearly dominated landings since 2008 although the proportion of recruits (conditions 1 and 2) has gradually increased during this period (Figure 23). The average size of legal-size crabs caught at sea has gradually decreased since 2008 and was well below average at 103.9 mm in 2012 (Figure 24).

The trap-based research survey, which has been conducted since 1996, indicates that the NUE of adults ≥ 95 mm was well below average from 2009 to 2011 before increasing sharply to above average levels in 2012. The abundance of intermediate-shell or old crabs (conditions 3, 4 and 5) remained below average from 2009 to 2012 (Figure 25) whereas recruits (conditions 1

and 2) have increased since 2009, peaking in 2012 (Figure 26). Thus, the post-season survey results suggest that the biomass available at the beginning of the 2013 season will be higher than it was in 2012. The average size of adult legal-size crabs has followed a downward trend since 2008, suggesting that the size of legal crabs caught in the commercial fishery will be smaller in 2013 than it was in 2012. The NUE of adolescents ≥ 78 mm has increased since 2010, reaching a well above average record value in 2012, foreshadowing the maintenance of high recruitment (Figure 26).

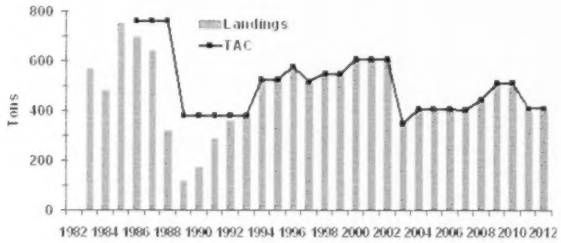


Figure 21. Landings and TAC in Area 14 from 1983 to 2012.

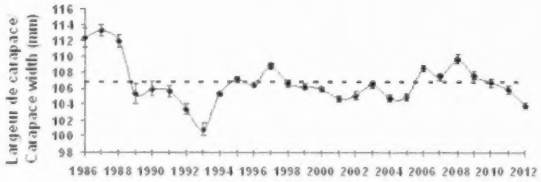


Figure 24. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1986 to 2012 in Area 14. The dotted line shows the data series average.

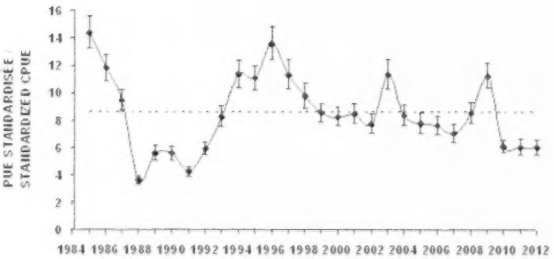


Figure 22. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2012 in Area 14. The dotted line shows the data series average.

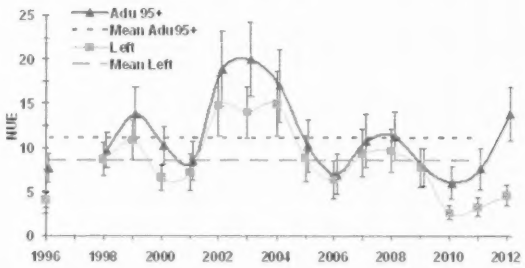


Figure 25. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 14 from 1996 to 2012.

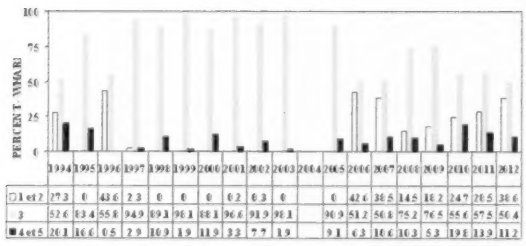


Figure 23. Carapace conditions for commercial crabs landed in Area 14 from 1994 to 2011.

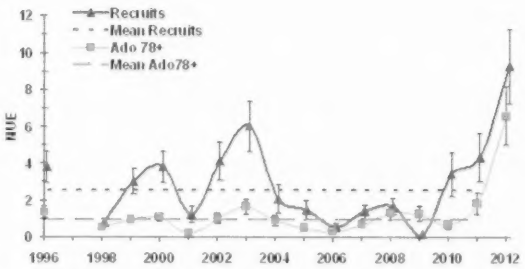


Figure 26. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 14 from 1996 to 2012.

The combined index of commercial CPUE and of NUE from the post-season survey increased significantly but did not reach a very high value. This index suggests that there will be more biomass available to the fishery in 2013 than there was in 2012.

Conclusion and advice

The TAC was 407 t in 2011 and 2012 and was met.

The commercial fishery catch rate has been stable but below average since 2010. In 2012, landings consisted primarily of intermediate-shell crabs although the proportion of recruits had been increasing since 2008.

The post-season survey suggests that the commercial fishery catch rate will be higher in 2013 than in 2012 and that landings will consist of a higher proportion of recruits.

The combined commercial CPUE and post-season NUE index suggests that there will be more biomass available in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery has decreased since 2009 and was well below average in 2012. It should remain low in 2013 according to the [missing text].

The post-season survey indicates that the abundance of adolescent crabs ≥ 78 mm and of recruits increased to the highest level in the series in 2012.

The increase in the combined biomass index and the high recruitment of legal-size crabs indicate that catches could be slightly increased without creating an excessively high harvesting intensity.

Recommendation

For 2013, increasing catches to a maximum of 10% of the 2012 TAC (447.7 t) would not result in an excessively high harvesting intensity.

Area 13

Description of the fishery

In Area 13, there are 43 fishers from Quebec and six from Newfoundland. The area was placed under a moratorium from 2003 to 2007 as a result of a sharp drop in biomass. However, an index fishery with an annual TAC of 50 t was approved in 2003, 2004 and 2006. The area was reopened to the commercial fishery in 2008 with a TAC of 150 t for 2008 and 2009. TACs were then set at 188 t for 2010 and 2011 and 169 t for 2012 (Figure 27). Landings totalled 163 t in 2012. The fishing season opened on May 13 and closed on July 28.

Resource status in 2012

The standardized CPUE from the commercial fishery had been on a downward trend from 2008 to 2011. It slightly increased in 2012, but to a value that remains below the 1988–2011 average (Figure 28). The area harvested since 2008 was relatively small compared to the total areas traditionally harvested and in 2012, the fishing effort was most concentrated in the south. Since 2008, intermediate-shell crabs (condition 3) have accounted for most of the landings (Figure 29). Since 2010, the proportion of recruits (conditions 1 and 2) has increased whereas that of old crabs (conditions 4 and 5) has decreased. The average size of legal-size crabs caught at sea has increased since 2010 and in 2012, it was 105.7 mm, well above the historical series average (Figure 30), but it remains low compared to other areas of the northern Gulf of St. Lawrence.

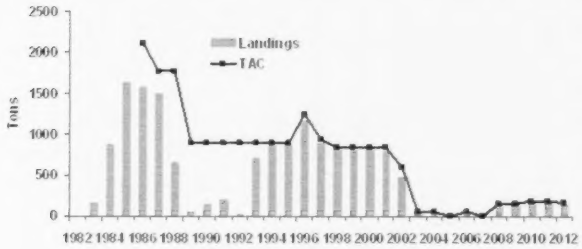


Figure 27. Landings and TAC in Area 13 from 1983 to 2012.

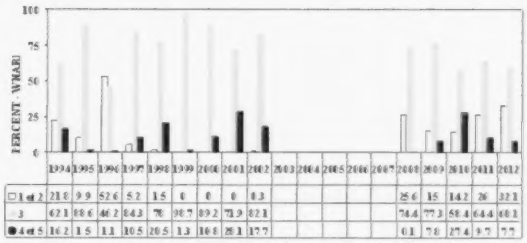


Figure 29. Carapace conditions for legal-size crabs landed in Area 13 from 1994 to 2012.

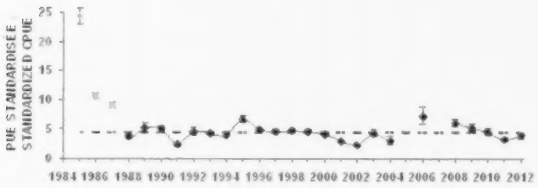


Figure 28. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2012 in Area 13. The dotted line shows the 1988–2011 data average.

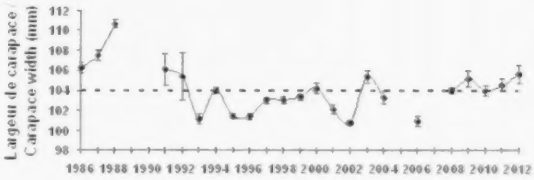


Figure 30. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1986 to 2012 in Area 13. The dotted line shows the data series average.

The **trap-based research surveys** conducted since 1999 indicate that the NUE of adults ≥ 95 mm peaked in 2008 and 2009 in the north, then decreased sharply until 2011 before increasing to above average in 2012 (Figure 31). For the south, the survey indicates that the NUE of adults ≥ 95 mm was high from 2006 to 2010 before decreasing to below average in 2011 and increasing to near average in 2012 (Figure 32). The north and south surveys indicate that intermediate-shell or old crabs (condition 3, 4 and 5) were the most abundant in the catches since 2006 (Figures 31 and 32), except in 2012 when there was a sharp increase in recruits in the north (Figure 33). In the south, recruits were abundant from 2004 to 2007, then their numbers decreased and abundance has been low since 2008 (Figure 34). In post-season surveys, the average size of adult crabs in 2012 decreased in the north of the area and increased in the south, suggesting a possible increase in crab size in commercial catches in 2013 if the distribution of the fishing effort continues to be higher in the south. The NUE of adolescent crabs ≥ 78 mm in the north went from the lowest value in the series in 2010 to the highest in 2012 (Figure 33). In the south, it decreased during this period, reaching the lowest value in the series in 2012 (Figure 34).

The combined index of commercial CPUE and of NUE from the post-season survey increased significantly but did not reach a very high value. This index suggests that there will be more biomass available to the fishery in 2013 than there was in 2012.

The 2012 **trawl survey** covering the northern part of Area 13 shows a sharp increase in recruits and in adolescent crabs between 78 and 95 mm, which is consistent with the post-season survey results. A review of size frequencies from 2006 to 2012 made it possible to monitor the progress of strong cohorts that constitute a recruitment wave that should drive the fishery in the north for a few years.

Insemination levels of trawl-caught primiparous females indicate an increase in mating success from 2008 to 2012, suggesting a greater availability of large adult males in the northern part of the area.

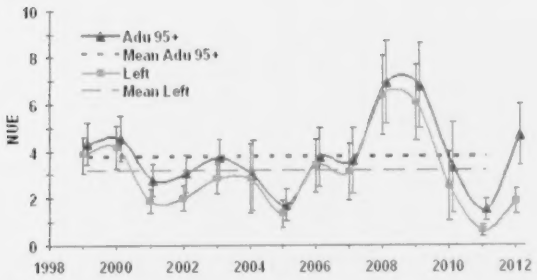


Figure 31. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 13 North from 1999 to 2012.

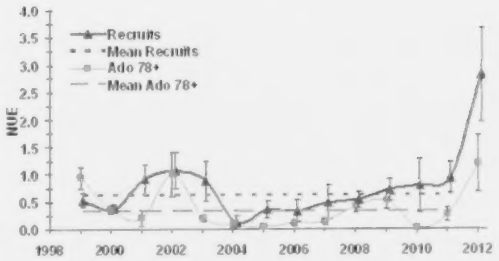


Figure 33. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 13 North from 1999 to 2012.

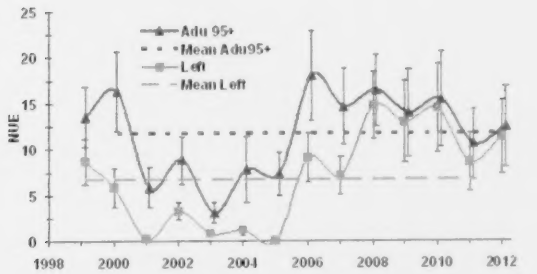


Figure 32. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 13 South from 1999 to 2012.

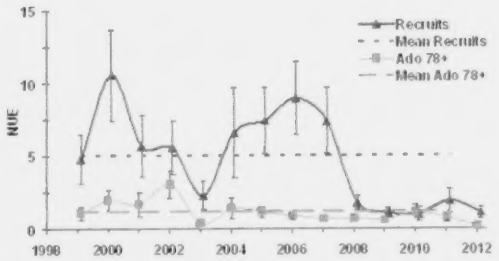


Figure 34. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 13 South from 1999 to 2012.

Conclusion and advice

Following a five-year moratorium (2003 to 2007), the area was opened with a TAC of 150 t for 2008 and 2009 and a TAC of 188 t for 2010 and 2011. The TAC was decreased to 169 t in 2012 and landings were 163 t.

The commercial fishery catch rate increased between 2011 and 2012 but remains below the 1988–2011 average. Fishing effort was higher in the southern part of the area. Since 2008, landings have consisted primarily of intermediate-shell crabs although the proportion of recruits has increased since 2010.

North and south post-season surveys suggest that the commercial fishery catch rate will be higher in 2013 than in 2012. If the fishing effort remains higher in the south, landings will still primarily consist of intermediate-shell crabs.

The combined commercial CPUE and post-season NUE index suggests that there will be more biomass available in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery was well above average in 2012 and according to the post-season survey in the south, it should remain high in 2013.

The post-season survey indicates a sharp increase in the abundance of recruits and of adolescents ≥ 78 mm in the north, which is consistent with the results of the trawl survey that indicates the presence of a recruitment wave in this part of the area. The south post-season survey indicates a slight decrease in recruits and adolescents.

The increase in the combined biomass index, coupled with stronger recruitment of legal-size crabs, suggests that catches could be increased slightly without creating an excessively high harvesting intensity.

Recommendation

An increase in 2013 catches to a value not exceeding 188 t would not result in an excessively high harvesting intensity.

Area 12A

Description of the fishery

Area 12A has 10 regular licences. The TAC decreased from 229 t in 2006 to 80 t in 2008 as a result of an overall decrease in commercial biomass abundance indices, and when the stock rebounded, it gradually increased to 162 t in 2012 (Figure 35). In 2012, the fishing season opened on March 20, closed on May 28 and the TAC was met.

Resource status in 2012

In the commercial fishery, the standardized CPUE went from the lowest value in the series in 2007 to the highest in 2011 before decreasing in 2012, but it is still well above average (Figure 36). Landings since 2005 have consisted primarily of intermediate-shell crabs (condition 3) whereas recruits (conditions 1 and 2) trended downward from 2008 to 2012 (Figure 37). Above average since 2008, the size of legal-size crabs caught at sea increased sharply from 2010 to 2011 to the highest value in the series and remained stable in 2012 at 112.2 mm (Figure 38).

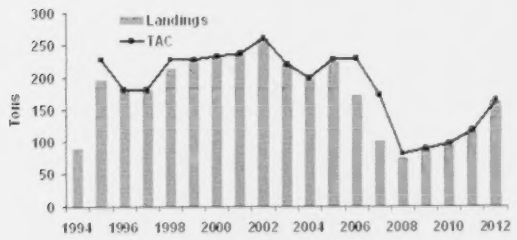


Figure 35. Landings and TAC in Area 12A from 1994 to 2012.

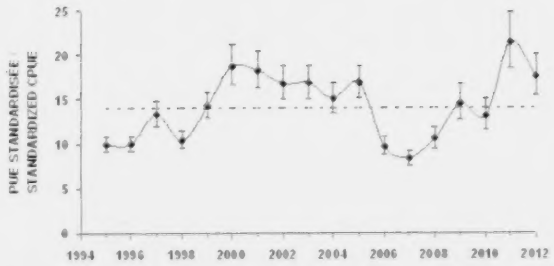
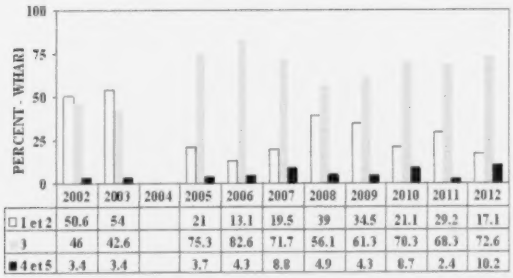


Figure 36. Standardized CPUE ± confidence interval in the commercial fishery from 1995 to 2012 in Area 12A. The dotted line shows the data series average.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
□ 1 et 2	50.6	54		21	13.1	19.5	39	34.5	21.1	29.2	17.1
3	46	42.6		75.3	82.6	71.7	56.1	61.3	70.3	68.3	72.6
■ 4 et 5	3.4	3.4		3.7	4.3	8.8	4.9	4.3	8.7	2.4	10.2

Figure 37. Carapace conditions for commercial crabs landed in Area 12A from 2002 to 2012.

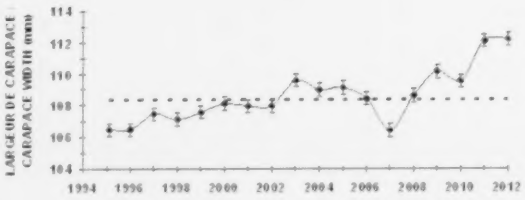


Figure 38. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1995 to 2012 in Area 12A. The dotted line shows the data series average.

The **trap-based research survey**, which has been conducted since 2000, indicates that the NUE of adults ≥ 95 mm increased in 2010 and 2011 to the highest value in the series but decreased significantly in 2012. The number of intermediate-shell or old crabs (conditions 3 to 5) followed the same trend (Figure 39).

The NUE of recruits, which was well above average in 2010 and 2011, decreased sharply in 2012 to well below average (Figure 40). Post-season survey results suggest that the biomass available at the beginning of the 2013 season will be lower than in 2012 and would consist primarily of intermediate-shell crabs. The 2012 post-season survey shows that the average size of legal-size adult males has decreased when compared with 2011, suggesting that crab size will be smaller in the 2013 fishing season. After being near or above the 2006–2011 historical average, the NUE for adolescents ≥ 78 mm has decreased sharply and was well below average in 2012 (Figure 40), foreshadowing low recruitment.

The combined index of commercial CPUE and of NUE in the post-season survey decreased in 2012, but remains above the values observed from 2006 to 2010. This index suggests that there will not be as much biomass available to the 2013 fishery as there was in 2012.

Note that the abundance of crabs in Area 12A is partially determined by overflow from adjacent areas (17 to the west and 12 to the east).

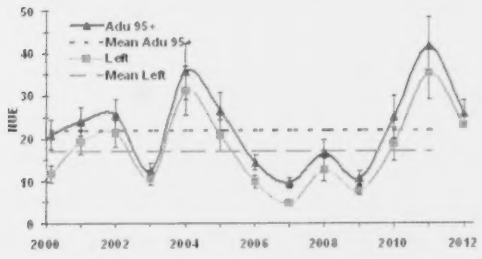


Figure 39. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 12A from 2000 to 2012.

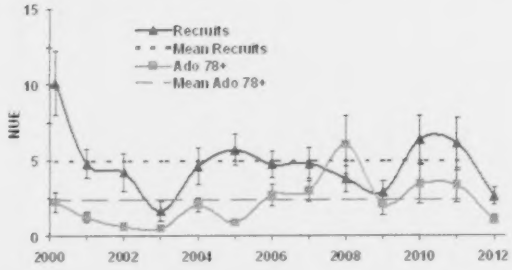


Figure 40. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 12A from 2000 to 2012.

Conclusion and advice

The TAC increased by 40% between 2011 and 2012 to 162 t and was met.

The catch rate during the commercial fishery decreased in 2012 but remains high. Landings consisted primarily of intermediate-shell crabs.

According to the post-season survey, fishing yields will decrease in 2013 and catches will consist primarily of intermediate-shell crabs.

The combined commercial CPUE and post-season NUE index suggests a decrease in the biomass available to the fishery in 2013 compared to 2012.

The size of crabs caught in the commercial fishery is at the highest value in the series since 2011, but should decrease in 2013 according to the post-season survey.

The post-season survey indicates a sharp decrease in the abundance of recruits and of adolescent crabs ≥ 78 mm to well below average values.

Maintaining 2012 catch levels or increasing them in 2013 would result in a harvesting intensity greater than that in 2012. An increase in catches may result in a greater reduction of the legal-size adult male biomass because of low recruitment; this would make the fishery more vulnerable to the presence of White Crab in catches when recruitment resumes in 2014.

Recommendation

Maintaining the 2012 TAC (162 t) for 2013 should avoid creating an excessively high harvesting intensity and guard against possible White Crab issues.

Area 12B

Description of the fishery

There are eight commercial fishing licences for Area 12B. The TAC gradually increased from 246 t in 2010 to 325 t in 2012 (Figure 41) and was met. In 2012, the fishing season opened on March 24 and closed on June 21.

Resource status in 2012

The standardized CPUE from the commercial fishery was below average from 2003 to 2009, then increased sharply in 2010 to well above average. It increased slightly in 2012 compared to 2011 (Figure 42). Landings since 2005 have consisted primarily of intermediate-shell crabs (condition 3) whereas the proportion of recruits (conditions 1 and 2) decreased by more than 50% in 2012 compared to 2011 (Figure 43). The average size of legal-size crab caught at sea has increased since 2009 and was well above average at 110 mm in 2012 (Figure 44).

The trap-based research survey, which has been conducted since 2001 (except in 2005), indicated a sharp decrease in the average NUE of adults ≥ 95 mm from 2001 to 2003, which remained below the series average until 2010 before increasing sharply to a value well above average in 2012 (Figure 45). The number of intermediate-shell or old crabs (conditions 3 to 5) caught followed the same trend, in particular with a significant increase in 2011 and 2012. The number of recruits (conditions 1 and 2) was very high in 2009 and 2010 before increasing sharply in 2011 and slightly in 2012 to a near-average value (Figure 46). The biomass available at the beginning of the 2013 season could therefore be above 2012 levels and would likely consist primarily of intermediate-shell crabs. The average size of legal-size adults was greater in the 2012 post-season survey than in the 2011 survey, which suggests that crab size will remain

high in the 2013 fishing season. The NUE of adolescents ≥ 78 mm, which was high in 2008, decreased in 2009 and remained near the series average until 2012 (Figure 46).

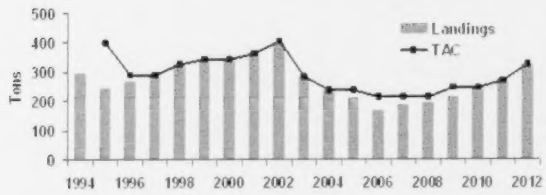


Figure 41. Landings and TAC in Area 12B from 1994 to 2012.

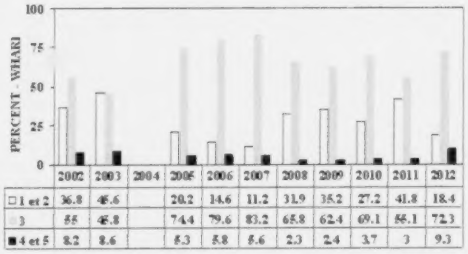


Figure 43. Carapace conditions for commercial crabs landed in Area 12B from 2002 to 2012.

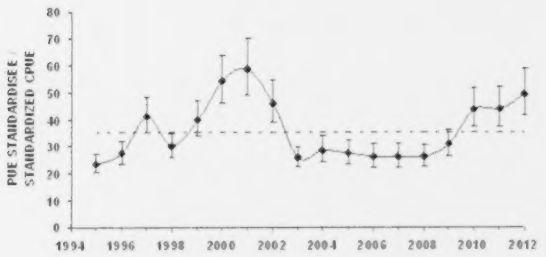


Figure 42. Standardized CPUE ± confidence interval in the commercial fishery from 1995 to 2012 in Area 12B. The dotted line shows the data series average.

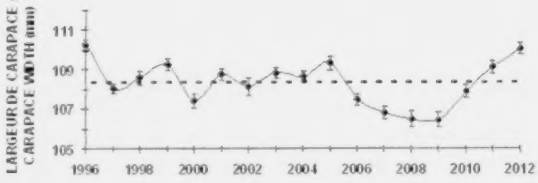


Figure 44. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1995 to 2012 in Area 12B. The dotted line shows the data series average.

The combined index of commercial CPUE and of NUE in the post-season survey increased to near a historic high in 2012. This index suggests that there will be more biomass available in the 2013 fishing season than there was in 2012.

Conclusion and advice

The TAC increased by 20% between 2011 and 2012 to 325 t and was met.

The catch rate in the commercial fishery increased slightly and is well above average. Landings consisted primarily of intermediate-shell crabs.

The post-season survey suggests that the commercial fishery catch rate will be higher in 2013 than in 2012. Landings should consist primarily of intermediate-shell or old crabs if the entire area is harvested.

The combined commercial CPUE and post-season NUE index is high and suggests that more biomass will be available in the 2013 season than there was in 2012.

The size of crabs caught in the commercial fishery has increased gradually since 2009 and was well above average in 2012. It should remain high in 2013 according to the post-season survey.

The 2012 post-season survey indicates that the abundance of recruits and of adolescents ≥ 78 mm remained near the historical average.

The increase in the combined biomass index and the maintenance of recruitment of legal-size crabs indicate that catches could be increased without creating an excessively high harvesting intensity.

Recommendation

An increase of 15 to 20% in the 2012 TAC for 2013 would not result in an excessively high harvesting intensity.

Area 12C

Description of the fishery

Area 12C includes two banks (north and south sectors) separated by the deep channel of the Jacques-Cartier Strait. Five regular fishers operate in the area. The TAC has been set at a maximum of 320 t since 2008 (Figure 47), including temporary allocations (100 t in 2012). The fishery opened on April 9 and closed on July 15. The TAC was met.

Resource status in 2012

The standardized CPUE from the commercial fishery plummeted between 1996 and 1997 and remained below average except from 2006 to 2008 despite a slight increase in 2012 (Figure 48). Since 2006, fishing effort has been more concentrated in the northern section of the area than in years prior. Since 2008, landings have consisted primarily of intermediate-shell crabs (condition 3) (Figure 49). Recruits (conditions 1 and 2) accounted for 40% of the crabs landed in 2012. After the highest value in the series since 1997 was reached in 2008, the average size of legal-size crabs caught at sea trended downward until 2012, but still remains above average at 110.7 mm (Figure 50).

The trap-based research survey conducted since 2000 shows that the NUE of adults ≥ 95 mm has been stable and near average since 2007 despite a slight increase in 2012 (Figure 51). The number of intermediate-shell or old crabs (conditions 3 to 5) reached the lowest value in the series in 2011 before increasing to a near-average value in 2012 (Figure 51). Conversely, the number of recruits (conditions 1 and 2) and adolescents ≥ 78 mm, which reached the highest values in the series in 2011, decreased, but to values that remain above average (Figure 52), suggesting that recruitment to the fishery will remain high. Post-season survey results suggest that the biomass available at the beginning of the 2013 fishery will be slightly higher than in 2012 and would consist primarily of intermediate-shell crabs. The average size of legal-size adult crabs has decreased slightly since 2008, suggesting that it could do likewise in 2013.

The combined index of commercial CPUE and of NUE from the post-season survey increased significantly in 2012 compared to 2011 but did not reach a very high value. This index suggests that there will be more biomass available to the fishery in 2013 than there was in 2012.

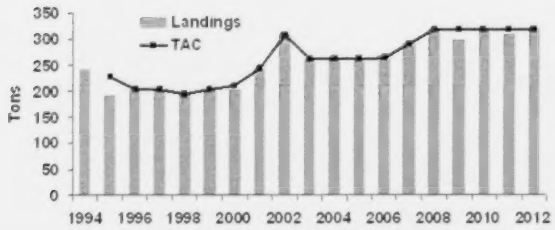


Figure 47. Landings and TAC in Area 12C from 1994 to 2012.

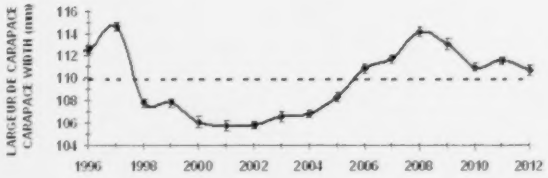


Figure 50. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 1995 to 2011 in Area 12C. The dotted line shows the data series average.

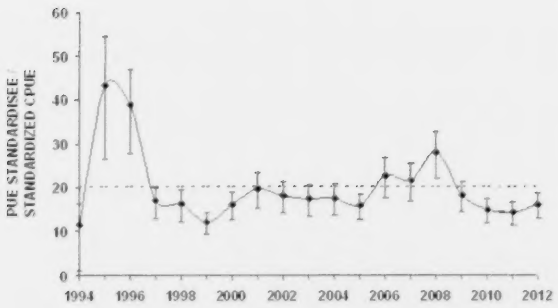


Figure 48. Standardized CPUE ± confidence interval in the commercial fishery from 1994 to 2012 in Area 12C. The dotted line shows the data series average.

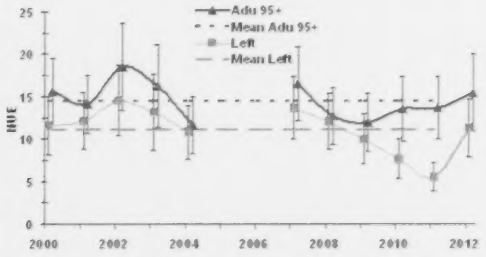
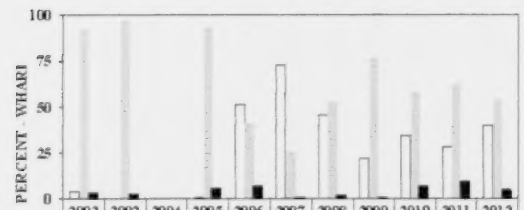


Figure 51. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 12C from 2000 to 2012 (except for 2005 and 2006).



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1 et 2	4.1	0		0.3	51.5	72.8	45	22.2	34.4	28	40.3
3	92.4	97.7		93.4	41.5	26.3	53.1	76.9	58.5	62.3	54.7
4 et 5	3.5	2.3		6.2	7	0.9	1.9	0.9	7.1	9.7	5

Figure 49. Carapace conditions for commercial crabs landed in Area 12C from 2002 to 2012.

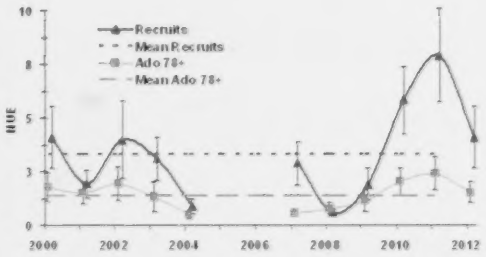


Figure 52. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 12C from 2000 to 2012 (except 2005 and 2006).

Conclusion and advice

The TAC has peaked at 320 t since 2008 and was met in 2012.

The commercial fishery catch rate has been below average since 2009 despite a slight increase in 2012. Landings consisted primarily of intermediate-shell crabs.

The post-season survey suggests that the commercial fishery catch rate will be slightly higher in 2013 than in 2012 and that landings will consist primarily of intermediate-shell crabs.

The combined commercial CPUE and post-season NUE index suggests that slightly more biomass will be available in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery decreased slightly in 2012 compared to 2011 but remains above average. It could decrease slightly in 2013 according to the post-season survey.

The post-season survey indicates a decrease in the abundance of adolescent crabs ≥ 78 mm and recruits to values that are near and slightly above average, respectively.

The slight increase in the combined biomass index and the maintenance of recruitment of legal-size crabs at an above-average level indicate that catches could be slightly increased without creating an excessively high harvesting intensity.

Recommendation

For 2013, increasing catches to a maximum of 10% of the 2012 TAC (352 t) would not result in an excessively high harvesting intensity.

Area 16A

Description of the fishery

Area 16A includes two banks (north and south sectors) separated by the deep channel of the Jacques-Cartier Strait. Since 2002, it has been accessible to the 43 Quebec fishers holding a Snow Crab fishing licence in Area 13. The TAC has peaked at 426 t since 2009 (Figure 53) and was met in 2012. The fishing season opened on April 9 and closed on July 15.

Resource status in 2012

The standardized CPUE from the commercial fishery peaked in 2008 but decreased to below average in 2009. This drop persisted despite a slight increase in 2012 (Figure 54). An increase in fishing effort in the southern section since 2010 resulted in a better distribution of fishing pressure between the north and south than in previous years. Since 2008, landings have consisted primarily of intermediate-shell crabs (condition 3), even though recruits (conditions 1 and 2) have represented a significant proportion since 2010. Old crabs (conditions 4 and 5), which accounted for close to 20% of landings in 2010 and 2011, decreased significantly in 2012 (Figure 55). The average size of legal-size adult crabs caught at sea decreased from 2008 to 2011 then increased sharply in 2012 to 111.7 mm (Figure 56).

The trap-based research survey, conducted since 2002, has shown little variation in NUE since 2006, except for 2009, when it decreased to well below average, and for 2012, when it increased to well above average (Figure 57). The number of intermediate-shell or old crabs (conditions 3 to 5), which had decreased since 2008, increased in 2012 (Figure 57). After decreasing steadily from 2002 to 2008, recruits have increased significantly since 2009 and their numbers have been high since 2010 (Figure 58). The trap survey suggests that

commercial biomass available at the beginning of the 2013 season will be greater than 2012 levels and that landings would once again consist primarily of intermediate-shell crabs. The average size of legal-size adult crabs ≥ 95 mm was greater in 2012 than in 2011, suggesting that the size of crabs to be landed in the 2013 fishing season will remain high. The NUE of adolescents in traps, which was relatively low from 2002 to 2009, has been high since 2010, foreshadowing high recruitment (Figure 58).

The combined index of commercial CPUE and of NUE from the post-season survey increased significantly but did not reach a very high value. This index suggests that there will be more biomass available to the fishery in 2013 than there was in 2012.

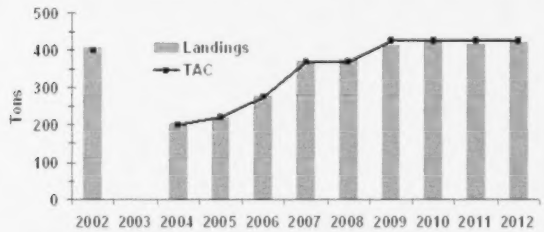


Figure 53. Landings and TAC in Area 16A from 2002 to 2012.

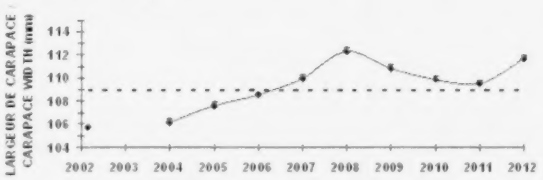


Figure 56. Average carapace width ± confidence interval for commercial-size crabs sampled at sea from 2002 to 2012 in Area 16A. The dotted line shows the data series average.

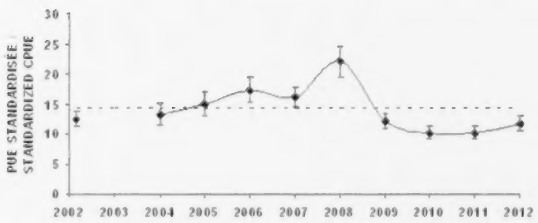


Figure 54. Standardized CPUE ± confidence interval in the commercial fishery from 2002 to 2012 in Area 16A. The dotted line shows the data series average.

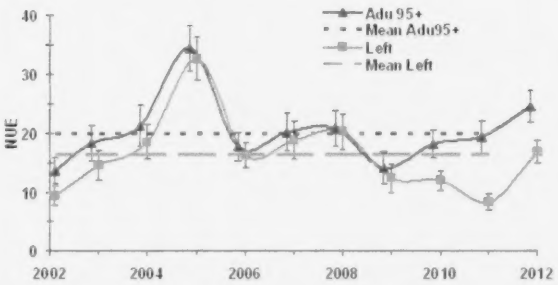
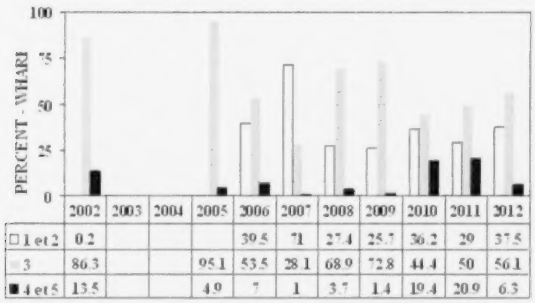


Figure 57. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the post-season survey fishery in Area 16A from 2002 to 2012.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1 et 2	0.2				39.5	71	27.4	25.7	36.2	29	37.5
3	86.3			95.1	53.5	28.1	68.9	72.8	44.4	50	56.1
4 et 5	13.5			4.9	7	1	3.7	1.4	19.4	20.9	6.3

Figure 55. Carapace conditions for commercial crabs landed in Area 16A from 2002 to 2012.

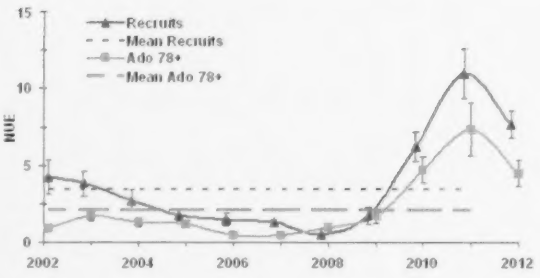


Figure 58. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 16A from 2002 to 2011.

Conclusion and advice

The TAC has peaked at 426 t since 2009 and was met in 2012.

The commercial fishery catch rate has remained low since 2009 despite a slight increase in 2012, when landings consisted primarily of intermediate-shell crabs although there was an increase in recruits.

The post-season survey suggests that the commercial fishery catch rate will be higher in 2013 than in 2012 and that landings will still consist primarily of intermediate-shell crabs.

The combined commercial CPUE and post-season NUE index suggests that there will be more biomass available in 2013 than there was in 2012.

The size of crabs caught in the commercial fishery in 2012 was greater compared to 2011 and well above average. It should remain high in 2013 according to the post-season survey.

The post-season survey indicates a high abundance of recruits and of adolescent crabs ≥ 78 mm since 2010, foreshadowing the maintenance of high recruitment in the short term.

The increase in the combined biomass index and the maintenance of high recruitment of legal-size crabs indicate that catches could be increased slightly without creating an excessively high harvesting intensity.

Recommendation

For 2013, increasing catches to a maximum of 10% of the 2012 TAC (i.e. to 468.6 t) would not result in an excessively high harvesting intensity.

Sources of uncertainty

The quality of science advice depends largely on the accuracy of parameters obtained through sampling and the subsequent analyses. Information obtained from logbooks and purchase slips during the fishing season affects the accuracy of the parameters derived from these documents. For instance, abundance indices and fishing effort calculations obtained from logbooks may include errors that will affect the science advice provided. The selectivity and catchability of traps can vary depending on the type of trap used, its volume and mesh size, the amount and quality of bait used and soak time, which can vary with fishing strategies employed and the prevailing environmental conditions. The catchability of adolescent crabs and recruits can also

be affected by the abundance of intermediate-size crabs (condition 3) on the seafloor. The selective sorting of catches can also affect the quality of the data obtained.

The abundance and condition indices and the estimates of crab size obtained from the trawl and trap surveys depend on the type of gear used and are affected by uncertainties related to catchability variations in the different crab groups targeted. Some types of fishing gear are better suited to given seafloor areas than other types and this factor influences the spatial coverage ultimately sampled. The biological characteristics specific to Snow Crabs can also create sources of uncertainty that impinge on the science advice. For instance, the terminal moulting phase, which occurs at various sizes, will affect crab condition and catchability. Natural mortality can also vary with the life stage and condition of the crabs.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 19–20, 2013 meeting on the Assessment of the Estuary and northern Gulf of St. Lawrence Snow Crab stocks. Additional publications from this meeting will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule.

Dufour, R. and J.-P. Dallaire. 2003. Status of snow crab populations in the St. Lawrence Estuary and the Northern Gulf of St. Lawrence from 1999 to 2001. DFO Can. Sci. Advis. Sec., Res. Doc. 2003/048.

DFO. 2012. Assessment of the Estuary and Northern Gulf of St. Lawrence (Areas 13 to 17, 12A, 12B, 12C and 16A) Snow Crab Stocks in 2011. DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2012/030.

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Sainte-Marie, B., T. Gosselin, J.-M. Sévigny and N. Urbani. 2008. The snow crab mating system: opportunity for natural and unnatural selection in a changing environment. Bulletin of Marine Science 83(1): 131–161.

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